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Profitability of Various Corn, Soybean, Wheat, and Alfalfa Cropping Systems

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Abstract

Producers are frequently most interested in economic comparisons of various cropping systems. We compared continuous corn (Zea mays L.) and continuous soybean [Glycine max (L.) Merr.] with 2-, 3-, and 5-year rotations, the latter two including wheat (Triticum aestivum L.) and alfalfa (Medicago sativa L.), using either chisel plow or no-tillage practices. Crop yield and returns to land and management were evaluated. Yields for continuous corn (C-C-C) were not different from those in rotation [corn-soybean (C-S), soybean-wheat/soybeancorn (S-W/S-C), or corn-soybean-alfalfa-alfalfa-alfalfa (C-S-A-A-A)] for either tillage practice, but rotated corn had lower nitrogen (N) inputs. Soybean yield in the 5-year rotation was greater than for continuous soybean (S-S-S) in 2001 for both tillage practices, but in 2000, a tillage by rotation interaction resulted from severe crusting in S-S-S that reduced stand density and lowered yield for the chisel plow treatment. Wheat and alfalfa yields were not affected by tillage practice. Using average annual crop prices, the 5-year rotation generated returns that were 100 and 158% higher than for C-S using either no-tillage or chisel practices. This study confirms that producers who incorporate alfalfa into their crop rotations can significantly increase returns to land and management. However, returns for the rotation including alfalfa are more realistic where a viable forage market exists.

Introduction

Crop rotation has been shown to increase corn yield 5 to 30% and soybean yield from 8 to 16% compared to continuous production of either crop (3,4,9,11,12,16,20). It has also been shown to improve N use efficiency by reducing requirements for external input of fertilizer N. Compared to C-C-C, Kanwar et al. (7) reduced fertilizer N inputs 17% for a C-S rotation and reduced $\rm NO_3$ -N leaching loss through subsurface tile lines. Bruulsema and Christie (1) found that single-year plowdown of alfalfa or red clover (*Trifolium pratense* L.) was equivalent to yields obtained from applying 80 to 111 lb/acre of fertilizer N. Fox and Piekielek (5) extended the evaluation period to three years of alfalfa managed as hay and reported that there was no significant grain yield response to fertilizer N for first-year corn.

One result of increased crop yield and improved N use efficiency with crop rotation may be more favorable economics or net return to producers. For example, when averaged for moldboard plow and chisel tillage systems in an Iowa study, Chase and Duffy (2) reported a return to land, labor, and management for continuous corn of \$142/acre compared to \$147/acre for corn rotated with soybean. The rotated corn also required 17% less N fertilizer (150 vs. 180 lb/acre). In New York, Singer and Cox (17) reported greater net return

for a C-S rotation (\$101/acre) than for C-C-C (\$78/acre) or a three year soybean-wheat/red clover-corn rotation (\$54/acre) with reduced inputs. Katsvairo and Cox (8) calculated that a C-S rotation with reduced inputs returned \$40/acre compared to \$5/acre in C-C-C with full inputs and chisel tillage. Similarly, Hesterman et al. (6) compared the profitability of alfalfa-corn (A-C), C-C-C, and C-S rotations and concluded that an A-C rotation provided the greatest returns. They also concluded that to amortize alfalfa establishment costs over a longer period of time, the crop should be managed as forage rather than a green manure.

Although the net returns are often the most requested piece of data when crop rotation studies are reported to producers, very few experiments have provided that information, especially those that include both forage and grain crops as well as tillage treatments. Our objective is to examine both crop yield and returns to land and management for monocultures (C-C-C and S-S-S) and rotations that include wheat and alfalfa. Comparisons are provided for both chisel-plow and no-tillage practices.

Materials and Methods

A tillage by crop rotation field study was established in the fall of 1998 on a Quakertown silt loam (fine-loamy, mixed, mesic Typic Hapludults) at the Rutgers University Snyder Research and Extension Farm near Pittstown, NJ (40°30'N, 75°00'W). The study was a randomized complete block design with a split plot arrangement of treatments that were replicated four times. The main plots (240 ft by 50 ft) were either chisel plowed or managed using no-tillage practices, although primary tillage was used only prior to corn or for full-season soybean production. Wheat and alfalfa seedbed preparation in the chisel plots was limited to a single tandem disking followed by one or two passes with a field cultivator. Double-crop soybean was planted no-till for both treatments to expedite planting and because it is the most common practice for double-crop systems. All field operations for tillage and crop rotation treatments are listed in Table 1.

Table 1. Field operations utilized for comparing chisel plow and no-tillage treatments for various crop rotations on a silt loam soil in New Jersey.

Field Operation	Continuous corn or corn-soybean	Corn after alfalfa	Soy- bean	Soybean after Wheat	Wheat	1st year alfalfa	2nd & 3rd year alfalfa		
	Chisel Plow								
Apply Iime ^a	X	Х	Х		Х	Х	Х		
Chisel plow	Х	Х	Х						
Tandem disk	Х	Х	Х		Х	Х			
Field cultivator	Х	Х	Х		Х	2X			
Spray		Х							
Plant/ fertilize	×	Х							
Plant									
Drill			Χ		Х	Χ			
No-till plant				X					
Spray	X	Xp	Χ	Х		Х			
Fertilize						2X	3X ^c		
Sidedress N	Х								
Topdress N					Х				
	No-Till ^d								
Plant/ fertilize	Х	Х							
Drill			Х						
Harvest ^e	X	Х	Х	Х	Х	Х	Х		

^a Applied lime to all plots in 2001.

All phases of each crop rotation were imposed on subplots (20 ft by 50 ft) when the study was initiated, thus creating C-C-C, S-S-S, C-S, C-S-W/S, and C-S-A-A-A treatments. The first two years (1998 and 1999) were considered establishment years, with soybean being planted late in 1998 to simulate typical double-crop planting dates. This study focused on the corn, soybean, wheat, and alfalfa yields during the 3rd (2000) and 4th (2001) years. Therefore, for corn we evaluated C-C-C, C-S-C, S-W/S-C, and A-A-C treatments (bold letters) in 2000

^b No spraying was done following planting in 2001.

^c Alfalfa was fertilized twice in 2001.

^d Chisel plow, tandem disk, and field cultivator operations were not conducted. No-till planting (with and without fertilizer) replaced conventional planting (with and without fertilizer). All other field operations remained the same as the chisel plow system.

^e Corn, soybean, and wheat were harvested with a combine. To estimate production costs, it was assumed that wheat straw was raked and baled and alfalfa was mowed, then raked and baled twice in the establishment year and four times in the 2nd and 3rd years, while the last cutting of alfalfa in each year was chopped as haylage.

and C-C-C-C, S-C-S-C, C-S-W/S-C, and A-A-A-C treatments in 2001. For soybean, we evaluated S-S-S, S-C-S, W/S-C-S, C-S-W/S, and A-C-S in 2000 and S-S-S-S, C-S-C-S, S-W/S-C-S, W/S-C-S-W/S, and A-A-C-S in 2001. Wheat was evaluated for the C-S-W/S rotation in 2000 and for S-C-S-W/S in 2001. For Alfalfa, we evaluated C-S-A, S-A-A, and A-A-A in 2000 and A-C-S-A, C-S-A-A, and S-A-A-A in 2001.

Pioneer Brand 33G29 corn was planted on May 4 and 8 in 2000 and 2001, respectively, at 29,600 seeds per acre in 30-inch rows with a John Deere 7200 corn planter. Pioneer Brand 93B53 soybean was planted on May 16 and 30 in 2000 and 2001, respectively, at 215,000 seeds per acre in 8-inch rows. Pioneer Brand 25R57 winter wheat was planted on October 26 and 30 in 1999 and 2000, respectively, in 8-inch rows at 1.3 million seeds per acre, and harvested on July 4 and 3 in 2000 and 2001, respectively. Pioneer Brand 93B01 double-crop soybean was planted following wheat on July 4 and 3 in 2000 and 2001, respectively, at 225,000 seeds per acre. Pioneer Brand P5347LH alfalfa was seeded in early spring, except in 1998, when it was seeded in mid-August, at a seeding rate of 15 lb/acre in 8-inch rows. Soybean, wheat, and alfalfa were all seeded with a no-till drill.

Wheat was topdressed with 60 lb of N per acre as ammonium nitrate in late March. Starter fertilizer (15-15-15 and 14-14-14 at 135 lb/acre in 2000 and 2001, respectively) was applied to all corn plots. An additional 0, 140, or 180 lb of N per acre was sidedressed as ammonium nitrate at V4 (14) to corn in the S-A-A-A-C, S-C, and C-C-C rotations in 2000 and 2001. Corn following double-crop soybean received 180 and 140 lb of N per acre in 2000 and 2001. A higher sidedress N rate was used for corn in 2000 because a severe drought in 1999 (data not presented) resulted in complete failure of the double-crop soybean treatment; thus, there was no N credit. No fertilizer was applied to either full-season or double-crop soybean. Alfalfa was fertilized two or three times each season with 0-26-26 and 0-0-50.

No herbicide was applied to wheat. Alfalfa was sprayed with Roundup[™] three days prior to corn planting. In 2000, corn following alfalfa was sprayed with Banvel[™] to control volunteer alfalfa in chisel and no-till. In 2001, corn following alfalfa did not receive additional herbicide inputs. Otherwise, all corn received recommended rates of Bladex[™] and Lasso Microtech[™] or Dual[™]. All soybean treatments were sprayed with 1 qt/acre RoundUp approximately four weeks after planting. New seeding alfalfa no-till plots were sprayed with RoundUp prior to planting in 2000 and all plots were sprayed with Butyrac[™] 2000 in 2000 and 2001 about 50 days after planting. Other miscellaneous inputs included a three-way seed box treatment for corn and soybean inoculum.

Corn, soybean, and wheat were all machine harvested after end-trimming plots. Grain yield was converted to 15.5, 13.0, and 13.0% moisture basis for corn, soybean, and wheat, respectively. Alfalfa was harvested three times in the seeding year, and five times each during the second and third years with a flail type forage harvestor. Subsamples were collected for moisture determination.

Machinery costs were determined by applying custom rate estimates to the cultural practices in each tillage and rotation combination as suggested by Stout and Cuffman (18) and Stout (19). Custom rates typically include a return for the operator's machinery and labor. The standardization of costs per operation eliminates differences from machinery repairs and depreciation and allows the focus to be on the practice. Seed, chemical, and fertilizer expenses were actual expenses. Miscellaneous expense was the interest on preharvest expenses.

The analysis of returns is presented in two parts: first, an analysis of returns to land and management using average crop prices; and second, an analysis of returns to land and management using the higher of average crop prices or government support price. Labor charges are included within the custom rates, therefore the returns are to land and management. Land charges are not considered in this study, thus, we assume debt charges, equity charges, real estate taxes, and other land ownership costs would not be affected by the tillage and rotation system selected.

Average New Jersey crop prices were not available for 2000 and 2001, so prices from Pennsylvania were used for corn and alfalfa and those from Ohio were used for soybean and wheat (10). These were the closest states to New Jersey reporting monthly prices for the crops included in this study. Average prices for 2000 and 2001 were \$2.32 and \$2.28/bu for corn, \$4.85 and \$4.56/bu for soybean, \$2.06 and \$2.43/bu for wheat, and \$136 and \$122/ton

for alfalfa, respectively. The average soybean and wheat prices were below the national loan rates of \$5.26 and \$2.58/bu, respectively, so the national loan rate values were used for our second analysis of returns to land and management. Wheat straw was valued at \$55 and \$50/ton for 2000 and 2001, respectively. Gross revenues were calculated by multiplying annual commodity prices by annual yields. Economic returns were calculated by subtracting production costs from gross revenues on an annual basis. Yield and system returns were tested for statistical significance using ANOVA procedures in SAS (15). Following determination of overall significance, Tukey's multiple range test (HSD) was used for testing statistical differences among individual treatments. Effects were considered significant if P-values < 0.05.

Results and Discussion

Crop yields were higher than average for all crops except wheat in both years (Table 2). Seasonal precipitation (May-September) was near average (21.5 inches) totaling 21.4 and 21.2 inches in 2000 and 2001, respectively. Growing degree days (GDD, 50-86°F) for May-September (2586 and 2861 GDD) were 8% below and 2% above normal, respectively, resulting in favorable growing conditions for summer annuals and alfalfa. A short dry period that lowered corn and soybean yield potential (1.4 inches compared to an average of 3.9 inches of rainfall) occurred in August 2001.

Table 2. Tillage and rotation effects on crop yield on a silt loam soil in New Jersey.

, v	Chisel			No-till			
Rotation/Crop	2000	2001	Ave.	2000	2001	Ave.	
	(bu/acre)						
C-C-C							
Corn	156a ^a	160a	158	138a	148a	143	
S-S-S							
Soybean	52b	44b	48	75a	55b	65	
C-S							
Corn	157a	164a	161	159a	168a	164	
Soybean	66ab	52ab	59	66ab	56ab	61	
C-S-W/S							
Corn	166a	156a	161	162a	152a	157	
Soybean	74a	48b	61	74a	53b	63	
Wheat	47a	36a	42	46a	33a	39	
Soybean	30c	35c	32	28c	34c	31	
C-S-A-A							
Corn	164a	163a	164	170a	141a	155	
Soybean	76a	59a	68	71a	59a	65	
	(tons/acre dry matter)						
Alfalfa - 1st	2.6a	4.1a	3.4	2.7a	4.8a	3.7	
Alfalfa - 2nd	5.2a	6.8a	6.0	4.9a	7.3a	6.1	
Alfalfa - 3rd	5.2a	7.2a	6.2	5.3a	7.5a	6.4	

^a Means followed by the same letter for the same year, crop and the same or different tillage system are not significantly different at P = 0.05.

Corn yield was not affected by year, tillage, or rotation. Statistical differences may have been observed in 2001 for rotation if corn stands and subsequent yields for the S-W/S-C and S-A-A-A-C treatments had not suffered cutworm [*Agrotis ipsilon* (Hufnagel)] damage after emergence in the no-till treatment. Averaged across years and tillage treatments, corn yield for C-C-C was 150

bu/acre compared to 159, 159, and 162 bu/acre in the S-W/S-C, S-A-A-A-C, and S-C rotations, respectively. Singer and Cox (16) reported similar or greater yield for corn in rotation with reduced inputs compared to continuous corn with full inputs. Katsvairo and Cox (8) found that 5-yr average corn yields in chisel tillage in C-C-C with broadcast herbicide, planter box insecticide, and the recommended sidedress N rate (120 lb/acre) yielded the same as C-S with no insecticide, banded herbicide plus cultivation, and half the sidedress N rate. However, corn in a S-W/red clover-C rotation in chisel tillage with reduced inputs yielded 8% more than C-C-C with full inputs in their study.

Soybean yield was influenced by year and rotation with significant year by rotation and tillage by rotation interactions. The year effect was probably caused by the low precipitation in August 2001 that reduced pod set and soybean yield compared to 2000. Rotation resulted in a highly significant response primarily because of the low soybean yield in the W/S double-crop treatment. Except for the tillage by rotation interaction in 2000, tillage treatment did not affect soybean yield. The interaction was caused by soil crusting and a subsequent 23 bu/acre reduction in yield for the chisel plow treatment compared to no-till S-S-S. Yields that year averaged 76 and 74 bu/acre for the W/S-C-S and A-A-A-C-S treatments, respectively, compared to 52 bu/acre for the chisel plow S-S-S treatment. In 2001, soybean yield was greater for the A-A-A-C-S treatment (59 bu/acre) compared to 44 and 48 bu/acre for the S-S-S and W/S-C-S rotations, respectively, for chisel and 55 and 53 bu/acre for no-till treatments. Continuous soybean performed surprisingly well with no-tillage in this study. It is not clear what reduced yield in the C-S rotation in 2000. Crookston et al. (4) also reported inconsistent soybean yield comparisons in a Minnesota study, whereby annually rotated soybean yielded less than monoculture soybean in certain environments.

Wheat and alfalfa yields were not affected by tillage treatment in either 2000 or 2001. First-year alfalfa yields were not different in a Michigan study comparing moldboard plow and no-till (13). In a New York study, wheat yields were 8% greater in moldboard plow compared to chisel or ridge tillage (8). Wheat yields were higher in 2000 because warmer temperatures prior to harvest hastened maturity and drying. In 2001, grain moisture was quite high at harvest, thus reducing test weight (*data not presented*) and yield. This was not unexpected because our research site is located on the northern range for double-crop soybean production. A compromise between wheat harvest and soybean planting was made because delayed planting would reduce double-crop soybean yield potential. The wheat was allowed to dry in the field as long as possible, but harvest still occurred approximately 10 days earlier than normal. Wheat straw yields were similar both years averaging approximately 1 ton/acre for both chisel and no-tillage treatments (*data not presented*).

Production costs by crop and rotation are presented in Table 3. The totals for corn with chisel plowing ranged from \$305 to \$319/acre for the C-C-C, C-S, and C-S-W/S rotations. Corn production costs for the C-S-A-A-A rotation were substantially lower (\$233/acre) because of lower fertilizer and herbicide costs. No-till corn production costs were typically \$31 to \$38/acre lower than for chisel plowing because of lower machinery expenses. Soybean production costs did not vary by rotation within tillage systems. With chisel plowing, soybean production costs were \$150/acre compared with \$119/acre for no-till. Average production costs for crops in rotation followed the same pattern as individual crops with no-till having an \$18 to \$38/acre cost advantage compared to chisel plowing.

Table 3. Average annual production costs (\$/acre) for tillage and crop treatments

evaluated on a silt loam soil in New Jersey.

	Corn					Wheat/ Soybean		Alfalfa ^b		A verage ^c	
Rotation/ Expense	Chisel	No- till	Chisel	No- till	Chisel	No- till	Chisel	No- till	Chisel	No- till	
C-C-C											
Machinery ^a	138	102							138	102	
Seed	50	50							50	50	
Chemical	32	32							32	32	
Fertilizer	85	85							85	85	
Misc.	14	12							14	12	
Total	319	281							319	281	
C-S										_	
Machinery	138	109	81	52					110	81	
Seed	50	50	43	43					47	47	
Chemical	32	32	11	11					21	21	
Fertilizer	71	71	8	8					40	40	
Misc.	14	12	7	5					10	8	
Total	305	274	150	119					228	197	
C-S-W/S											
Machinery	139	107	81	52	143	110			121	90	
Seed	50	50	43	43	78	78			57	57	
Chemical	32	32	11	11	13	13			19	19	
Fertilizer	78	78	8	8	28	28			38	38	
Misc.	14	12	7	5	6	5			9	7	
Total	313	279	150	119	268	234			244	211	
C-S-A-A-A											
Machinery	136	103	81	52			192	185	158	141	
Seed	50	50	43	43			16	16	28	28	
Chemical	14	14	11	11			5	5	8	8	
Fertilizer	24	24	8	8			146	146	94	94	
Misc.	9	7	7	5			1	1	4	3	
Total	233	198	150	119			360	352	292	274	
S-S-S											
Machinery			81	52					81	52	
Seed			43	43					43	43	
Chemical			11	11					11	11	
Fertilizer			8	8					8	8	
Misc.			7	5					7	5	
Total			150	119					150	119	

^a Corn machinery expenses include field operations, drying, and hauling. Machinery expenses for all other crops include field operations and hauling. Land costs are not included.

Average returns to land and management using average annual crop prices are presented in Table 4. The average return for corn in a C-S-A-A-A rotation was \$151/acre and was not affected by tillage system. This net return was significantly higher than for all other chisel rotations and for no-till C-C-C and C-S-W/S rotations. No differences were observed between chisel and no-till C-C-C or chisel and no-till corn following soybean. Chase and Duffy (2) reported

^b Alfalfa costs are the average of the 1st, 2nd, and 3rd years.

^c Totals rounded to the nearest dollar.

similar returns to land, labor, and management for continuous corn and corn following soybean. Katsvairo and Cox (8) calculated net returns for C-S compared to C-C-C were \$48 greater in chisel tillage under high inputs mainly because of higher corn yields in C-S. Corn yields in chisel tillage were 158 and 161 bu/acre in C-C-C and C-S, respectively, in our study, which resulted in similar returns to land and management in the corn phase (\$45 and \$64). In notill, corn yields averaged 143 and 164 bu/acre, which resulted in different returns for C-C-C and corn in the C-S rotation (\$46 vs. \$102). However, although numerical differences were apparent for the C-S compared to the C-C-C rotation in chisel (\$95 vs. \$45) and no-till (\$135 vs. \$46), these differences were not significant.

Table 4. Average returns (\$/acre) to land and management using average annual crop prices for various tillage and crop rotation treatments evaluated on a silt loam soil in New Jersey.

oam soil in New Jersey.							
Tillage/Rotation	Corn	Soybean	Wheat	Alfalfa ^a	Average		
Chisel							
C-C-C	45d ^b				45c		
C-S	64cd	127ab			95c		
C-S-W/S	57cd	138ab	29a		75c		
C-S-A-A	143ab	169ab		304a	245ab		
S-S-S		77b			77c		
No-till							
C-C-C	46d				46c		
C-S	102bc	168ab			135bc		
C-S-W/S	82cd	180ab	50a		104c		
C-S-A-A	159a	186a		337a	271a		
S-S-S		188a			188abc		

^a Alfalfa returns are the average of three years.

Soybean returns were not significantly different with the exception of the chisel S-S-S rotation (\$77/acre), which was significantly lower than for no-till C-S-A-A-A (\$186/acre) and no-till S-S-S rotations (\$188/acre). Lower yield for the chisel S-S-S rotation than for either the no-till S-S-S or C-S-A-A-A was responsible for the lower return. Our analysis of the rotation effects over a 2-year period revealed that the chisel C-S-A-A-A, no-till C-S-A-A-A, and no-till S-S-S rotations were not significantly different averaging \$245, \$271, and \$188/acre, respectively. However, the long-term profitability of the S-S-S rotation in no-till is questionable because of potential pest and disease problems. Average returns for the two alfalfa rotations were significantly higher than for the rest of chisel plow rotations and the no-till C-C-C and C-S-W/S rotations.

Returns to land and management using the higher of average crop price or government support price are presented in Table 5. Because the actual price for corn was higher than the national loan rate in 2000 and 2001, the returns are the same as in Table 4. Average soybean prices were lower than the national loan rate (\$5.26/bu). Using that value, the only significant difference among soybean returns was that the chisel plow S-S-S rotation (\$103/acre) was significantly lower than the no-till S-S-S (\$222/acre), no-till C-S-A-A-A (\$278/acre), no-till C-S-W/S (\$214/acre), and chisel plow C-S-A-A-A (\$206/acre) rotations. For the rotational averages, there were no significant differences among no-till C-S-A-A-A (\$278/acre), chisel plow C-S-A-A-A (\$252/acre), or no-till S-S-S (\$222/acre) rotations. The average return for the two alfalfa rotations was significantly higher than for the rest of the chisel plow rotations and for the no-till C-C-C and C-S-W/S rotations.

^b Returns within columns followed by the same letter are not significantly different at P = 0.05.

Table 5. Average returns (\$/acre) to land and management using the higher of the average annual crop prices or government support prices for various tillage and crop rotation treatments evaluated on a silt loam soil in New Jersey.

Tillage/ Rotation	Corn	Soybean	Wheat	Alfalfa ^a	Average
Chisel					
C-C-C	45d ^b				45c
C-S	64cd	159ab			111c
C-S-W/S	57cd	170ab	62a		97c
C-S-A-A-A	143ab	206a		304a	252ab
S-S-S		103b			103c
No-till					
C-C-C	46d				46c
C-S	102bc	201ab			151bc
C-S-W/S	82cd	214a	82a		126c
C-S-A-A-A	159a	221a		337a	278a
S-S-S		222a			222abc

^a Alfalfa returns are the average of three years.

This study did not take into consideration the total influence of any government programs. Loan rates were used to incorporate loan deficiency payments due to low conventional soybean and wheat prices throughout the two-year study period. The transition payments that have been a component of the 1995 Farm Bill were not included. We would argue that the transition payments would be the same regardless of which rotation was initiated in 2000 because the 1995 corn acres would not have been altered. This study also used custom rates for determining machinery cost. An alternative method would be to use standardized costs for machinery (fixed and variable) and to calculate a separate labor expense. Separating labor would enable us to determine the total number of hours required for each rotation by tillage treatment combination. This could be important for different farm sizes and whole-farm returns could be substantially different given a fixed number of labor hours available per month or year. Finally, we recognize the limitations associated with the short duration of this study. Ideally for an economic analysis, crop yield would be measured for several years to account for variable growing conditions and other factors. However, due to a career change, the field study was terminated after just four years.

Conclusions

Our results indicate there was no economic advantage for using chisel plowing or no-tillage systems. Differences in returns to land and management were more closely related to crop rotation. Incorporating alfalfa into the rotation generated significantly higher returns to land and management regardless of actual price or government support price for all cropping systems except no-till S-S-S. The no-till and chisel plow C-S-A-A-A rotations attained the two highest returns under both price scenarios, averaging 100 and 158% more, respectively, than the C-S rotation using the average annual crop prices. Therefore, producers that incorporate alfalfa into their crop rotation can significantly increase returns to land and management. However, returns for the rotation including alfalfa are more realistic where a viable forage market exists.

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